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REMARKS

Reconsideration of the rejection of claim 1 under 35 USC §102 as anticipated by the prior art is respectfully requested. Claim 1 has been amended to recite “using microorganisms to concentrate and eliminate radionuclides in the radioactive water of spent nuclear fuel pools” (emphasis added).

Applicants submit that none of the cited art discloses or suggests bioremediation of the water in the specific nuclear environment of spent nuclear fuel pools. These pools for containing spent nuclear fuel are well known in nuclear engineering, the field of this invention, and the research resulting in the development of this invention was conducted at the nuclear power plant in Confrontes (Valencia, Spain). Enriched uranium is typically used as fuel by placing uranium oxide pellets in hollow bars made of a zirconium alloy. When the fuel is spent, i.e., it cannot adequately produce energy, it must be replaced in the process known as refueling. The spent nuclear fuel, however, continues to be thermally and radiologically active and must be stored. This spent fuel may be stored in pools of water to cool the fuel and to protect the workers. The quality of the water in such a nuclear pool is strictly controlled as to purity and clarity to allow maintenance personnel to correctly place the fuel elements on submerged racks. The water is cooled and purified in a closed-loop system that includes filtration and demineralization to ensure ultra-purity of the water.

The main structural materials of the primary coolant systems of nuclear power reactors are formed of stainless steel, carbon steel, higher nickel alloys and zirconium alloys. The Fe-Cr-Ni alloys contain cobalt as an impurity, and many systems employ alloys of high cobalt content as the valve seat material or other critical parts requiring wear resistance. Oxide films develop on the surfaces of these elements during operation of the reactor due to the interaction of these materials with the high temperature aqueous coolant. The corrosion products released to the coolant are transported throughout the core and are neutron activated, thereby generating activated corrosion products containing radionuclides, such as 60-Co, 58-Co, 54-Mn, 65-Zn, and 51-Cr. The water in these pools, therefore, contains dissolved corrosion products from the surfaces of the system components along with significant amounts of radioactivity contributed by these isotopes, which exhibit relatively long half-lives and significant gamma energies. This is especially true in the case of the Co isotope (1.17 and 1.33Mev). In fact, 60-Co is identified as a prime contributor to the observed radiation.

Currently, this radioactive water is processed with synthetic organic ion-exchangers, which have limited exchange capacities (1-2 eq/liter) and generate large waste volumes. The used ion-exchange columns are disposed of in specially built tile holes of carbon steel pipe lined with concrete, which is very expensive.

It will be appreciated that microbial activity in the ultrapure water of these nuclear pools is very unusual. But, such microbial activity has been detected, and microorganisms are present, not only in the water itself, but also in the austenitic stainless steel walls cladding the pools. It is these biofilms that are employed in the invention for bioremediation of the water in the spent nuclear fuel pools.

Against this background, it is submitted that it is clear that the cited prior art fails to teach or even remotely suggest that the microorganisms found in these pools can be used to treat the water as recited in the claims herein.

Rather, Hard discloses "methods of decontaminating pit and flooding water in disused uranium mines or washing water from soil refining plants". See, abstract. It is clear, therefore that Hard does not disclose or suggest the use of microorganisms to concentrate and eliminate radionuclides in the radioactive water of "spent nuclear fuel pools" as required by claim 1.

Francis discloses that "high concentration nitrate wastes can be effectively denitrified by passing the waste with a source of carbon continuously in an upflow mode through a column packed with a support having attached thereto denitrifying bacteria". See, col. 2, lines 30 – 35. Francis further discloses that "large quantities of wastewater effluent containing high nitrate concentrations are generated in nuclear fuel processing operations and at uranium oxide fuel fabrication plants". See, col. 1, lines 65 – 68. It is clear, therefore that Francis also does not disclose or suggest the use of microorganisms to concentrate and eliminate radionuclides in the radioactive water of "spent nuclear fuel pools" as required by claim 1.

Revis discloses that "Waste waters from mining and public utilities also contain toxic heavy metals or their compounds". See, col. 1, lines 24 – 25. However, Revis does not disclose or suggest a method of concentrating and eliminating radionuclides in the radioactive water of "spent nuclear fuel pools" as required by claim 1.

Furthermore, Revis discloses a process for reducing the concentration of ionic species of at least one heavy metal in an aqueous waste solution including "contacting the aqueous waste solution containing ionic species of at least one heavy metal with a culture of a *Pseudomonas*

organism in the presence of an amount of nutrient medium". See, col. 2, lines 19 – 29. However, Revis does not disclose a method of using microorganisms to "concentrate and eliminate radionuclides" as required by claim 1.

Chaumont discloses an apparatus for purifying a liquid effluent. Further, Chaumont discloses that "numerous industrial processes lead to the formation of effluents containing metals...or heavy metals.... Other processes lead to the formation of radionuclides such as uranium". See, col. 1, lines 12 – 18. However, Chaumont does not disclose or suggest using microorganisms in a "spent nuclear fuel pool" as required by claim 1.

The German Patent concerns a procedure for cleaning of metal-loaded drainage waters, waste dump seeping water, or flow-thru pit water in the mining industry. It is clear, therefore, that the German Patent does not disclose or suggest a method of concentrating and eliminating radionuclides in the "radioactive water of spent nuclear fuel pools" as required by claim 1.

Finally, Ashley gives an overview of the feasibility of the application of biotechnology to nuclear waste treatment. It does not disclose or suggest the application of biotechnology to radioactive water of "nuclear spent fuel pools" as required by claim 1.

Further, Ashley discusses only the potential of utilizing biotechnological applications such as biomagnetic separation technology, genetic engineering and monoclonal antibody technology to remove radionuclides from industrial nuclear effluents. See, abstract. As such, Applicants respectfully submit that Ashley is simply not an enabling disclosure that would allow one of ordinary skill in the art to use "microorganisms to concentrate and eliminate radionuclides in the radioactive water of spent nuclear fuel pools" as required by claim 1.

Alvarez discloses methods for "remediation of groundwater and wastewater utilizing iron-bacterial compositions in a variety of devices including batch reactors, permeable and semipermeable reactive barriers, flow-through reactors, fluidized bed reactors, and sediment tanks". See, abstract. It is clear, therefore, that Alvarez does not disclose a method for concentrating and eliminating radionuclides in radioactive water of "nuclear spent fuel pools" as required by claim 1.

As such, claim 1 is in condition for allowance over the cited art. Claims 2 through 4 depend from independent claim 1 and are also in condition for allowance for at least the reasons given above for claim 1. Reconsideration and withdrawal of the rejections to claims 1 through 4 are respectfully requested.

In addition, dependent claim 2 recites "using a bioreactor containing a metallic material wound into a ball, that is non-corrosive or non-degradable when exposed to the radioactive water of nuclear pools" (emphasis added).

Alvarez was cited against claim 2, but this reference discloses the use of Fe(0) which will "enhance microbial activity by serving as electron donor...to support hydrogenotrophic growth and reductive biotransformations". See, col. 16, lines 57 - 60. Specifically, Alvarez discloses that "when Fe(0) is immersed in anoxic water is produced (Reardon, 1996): $\text{Fe}^0 + 2\text{H}_2\text{O} \rightarrow \text{Fe}^{2+} + 2\text{OH}^- + \text{H}_2$ ". See, col. 17, lines 23 - 26. Thus, clearly Alvarez discloses the use of a corrosive and degradable metal in water. This is clearly contrary to the use of a metallic material that is "non-corrosive or non-degradable" as required by claim 2.

Reconsideration of the rejection of claims 5-10 as unpatentable over Alvarez is also respectfully requested. In addition to the arguments presented above, it is noted that claim 5 has been amended to recite the limitation that the microorganisms are viable but not culturable and that they are capable of retaining cobalt 60. Alvarez has no suggestion of such and appears to teach the use of culturable organisms.

The examiner has noted that the claims do not specifically recite other features but it is submitted that the claims are distinct from the references as set forth above because of the features that are indeed recited. For example, the features of a nuclear pool for spent fuel are inherent as explained above and that the arguments are valid.

Accordingly, it is submitted that this application is in condition for allowance, and an early indication thereof is respectfully requested.

All necessary extensions of time are hereby requested. Please charge any fees due, including any fee deficiency and credit any excess to deposit account 50-1088.

Respectfully submitted,
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